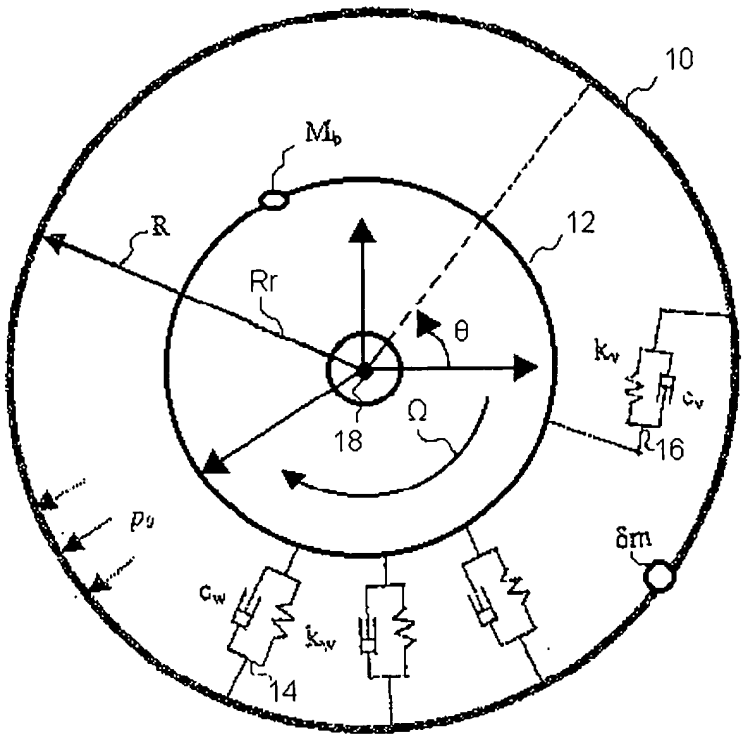

Figure 1

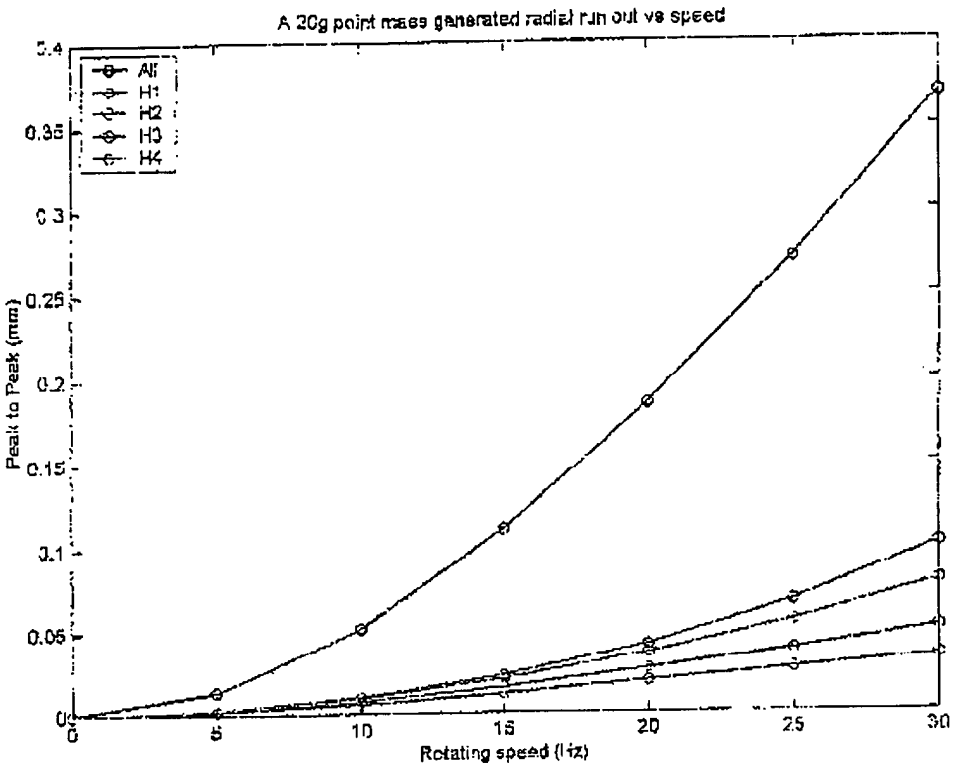
A 20g point mass generated radial run out vs speed
Peak to Peak (mm)
Rotating speed (Hz)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
5
10
15
20
25
30

Figure 2

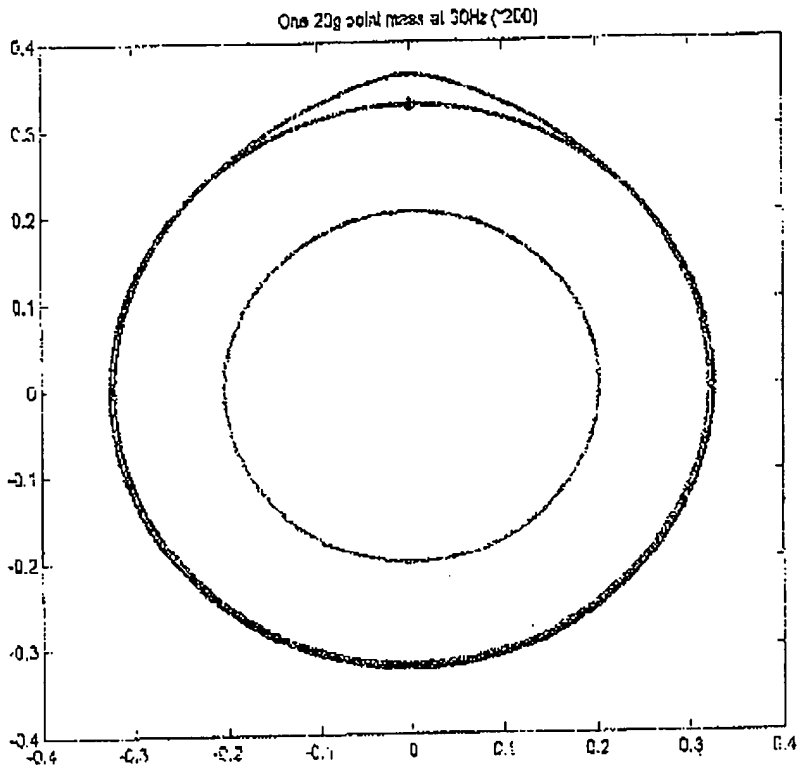
One 20g point mass at 30Hz (*200)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4

Figure 3

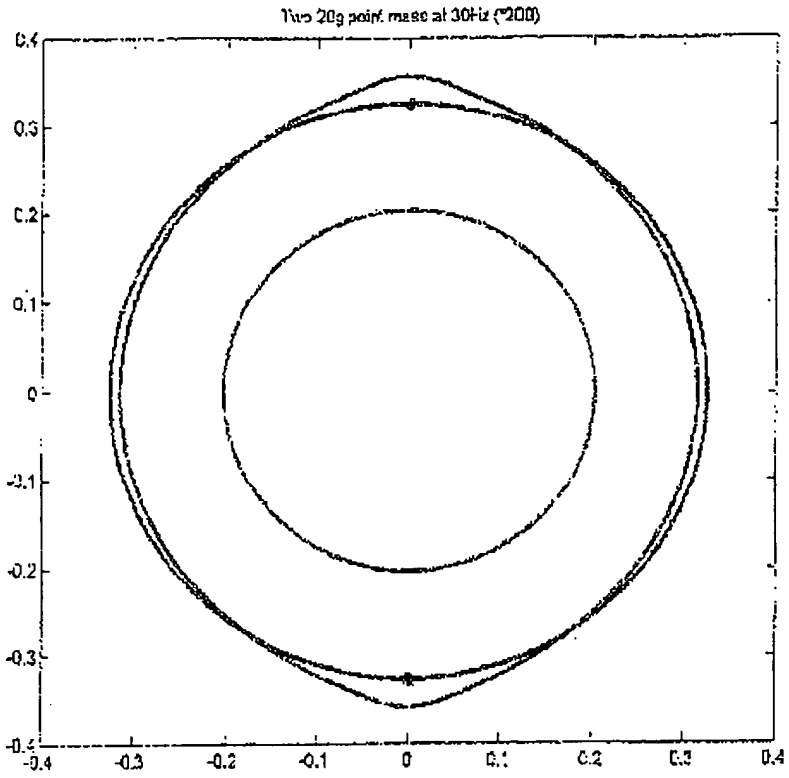
Two 20g point mass at 30Hz (*200)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4

Figure 4

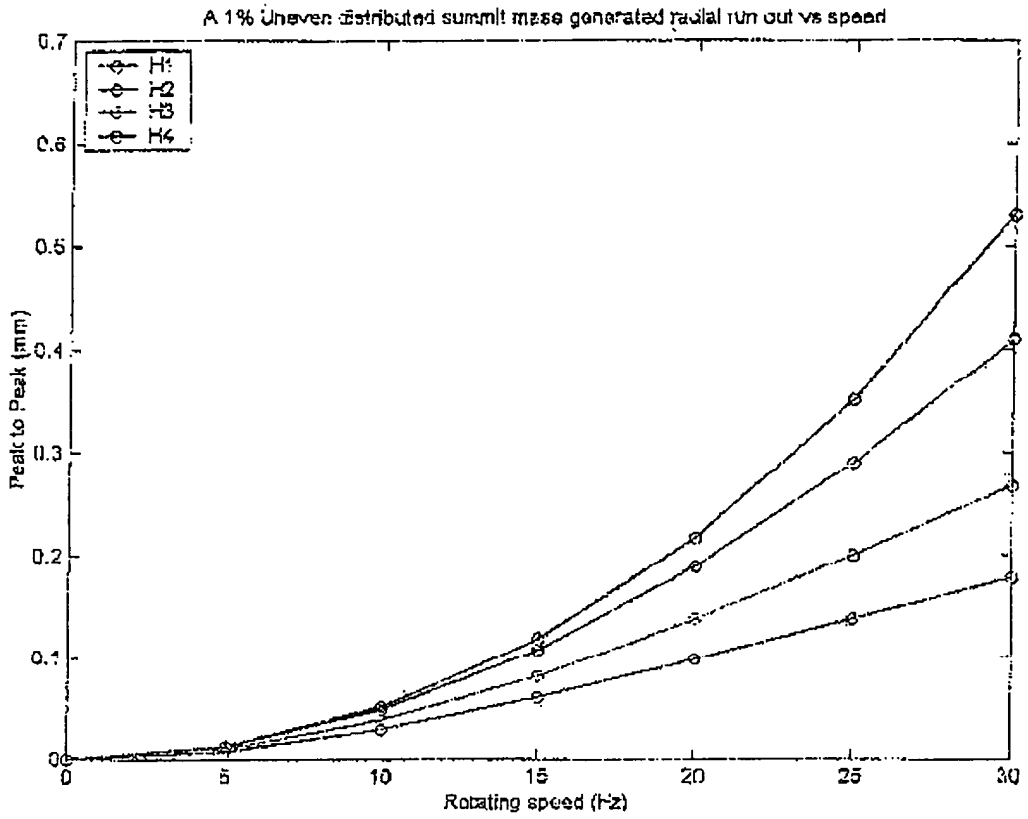
A 1% Uneven distributed summit mass generated radial run out vs speed
Peak to Peak (mm)
Rotating speed (Hz)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
5
10
15
20
25
30

Figure 5

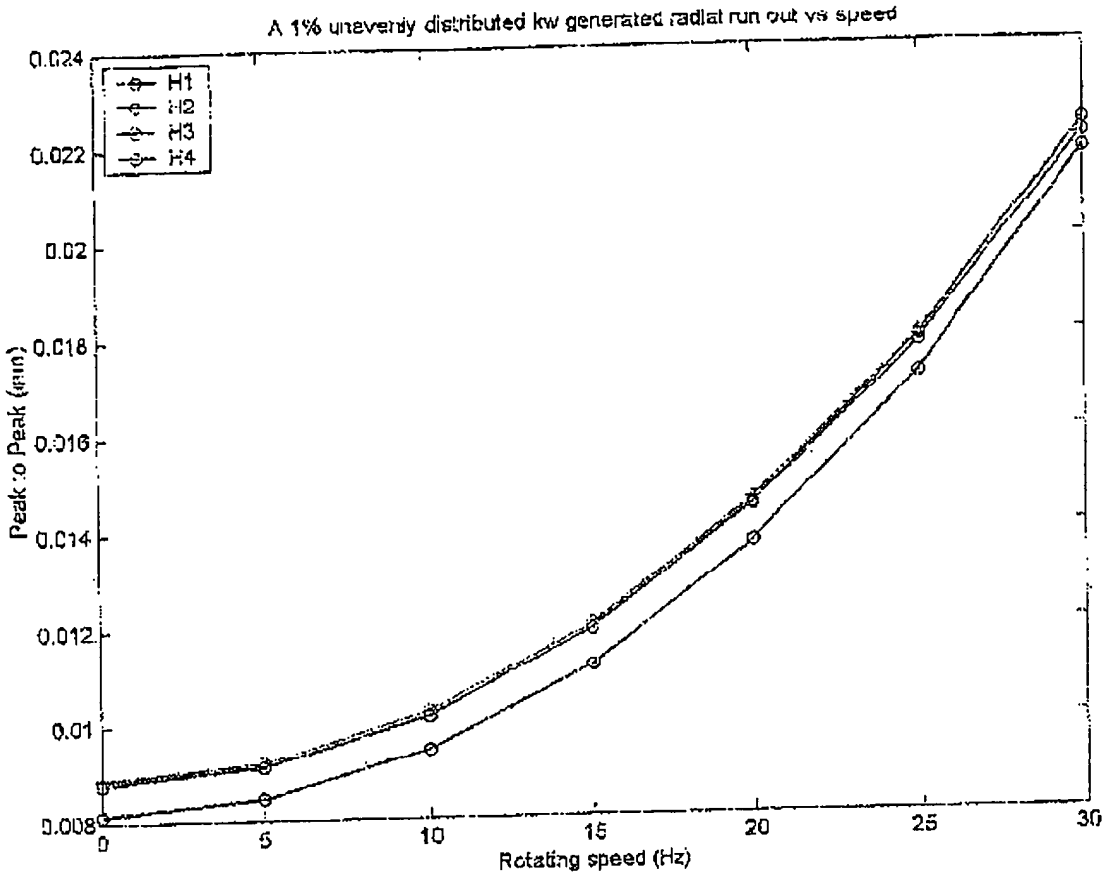
A 1% unevenly distributed kw generated radial run out vs speed
H1
H2
H3
H4
0.024
0.022
0.02
0.018
0.016
0.014
0.012
0.01
0.008
Peak to Peak (mm)
0
5
10
15
20
25
30
Rotating speed (Hz)

Figure 6

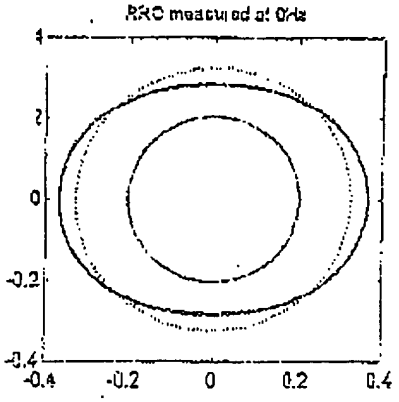

Figure 7A

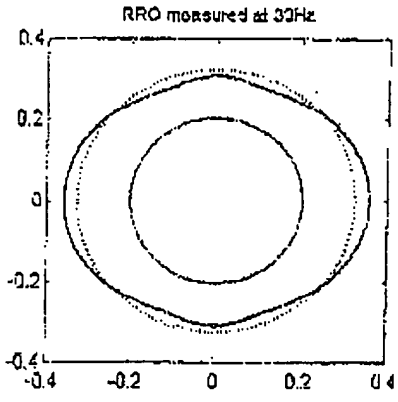

Figure 7B

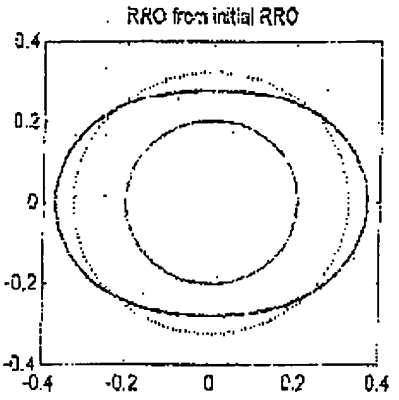

Figure 7C

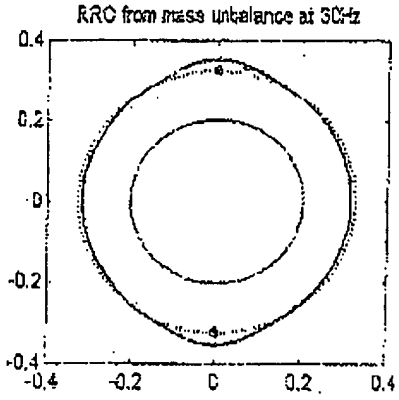

Figure 7D

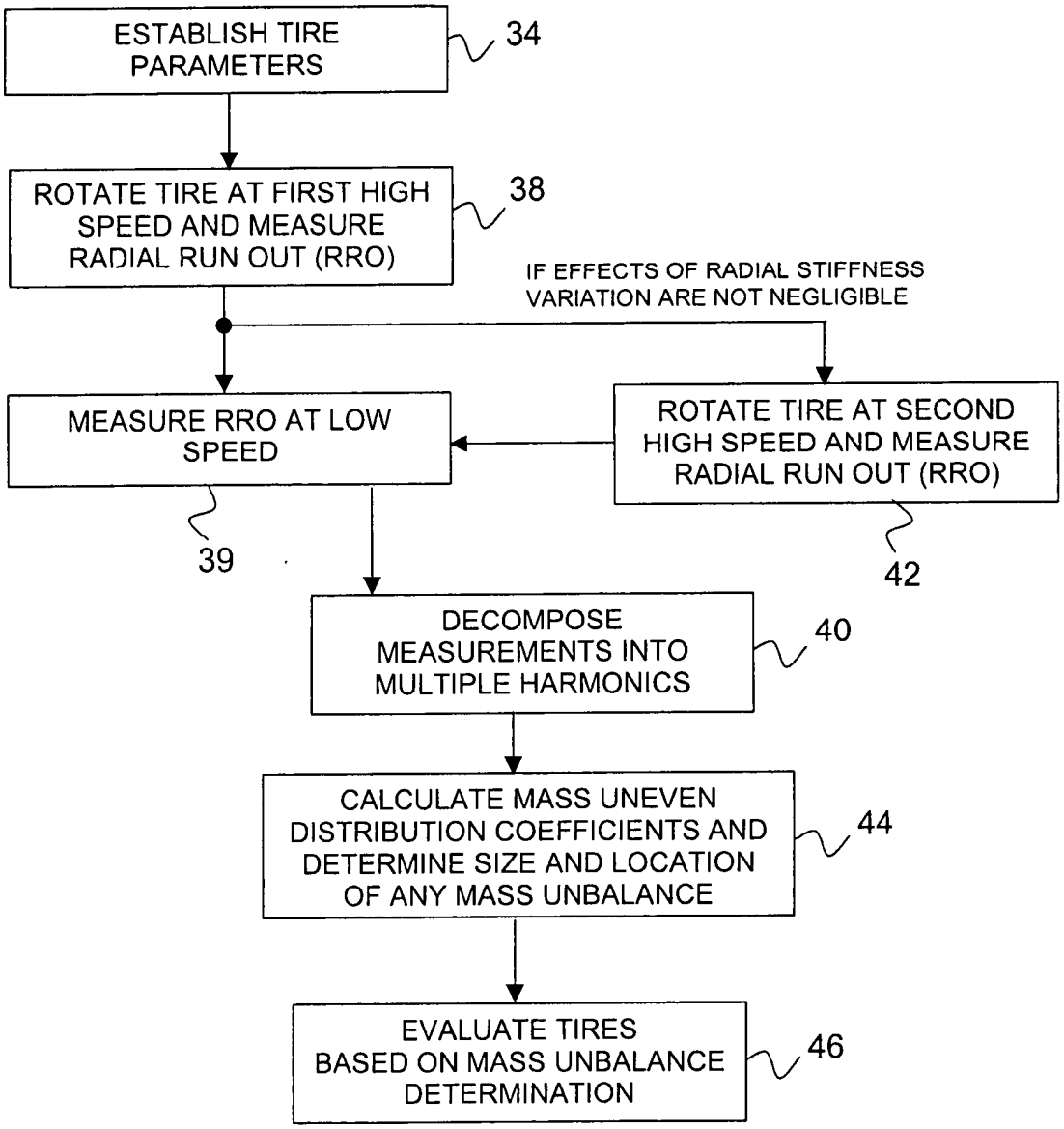
ESTABLISH TIRE PARAMETERS
34
ROTATE TIRE AT FIRST HIGH SPEED AND MEASURE RADIAL RUN OUT (RRO)
38
IF EFFECTS OF RADIAL STIFFNESS VARIATION ARE NOT NEGLIGIBLE
MEASURE RRO AT LOW SPEED
ROTATE TIRE AT SECOND HIGH SPEED AND MEASURE RADIAL RUN OUT (RRO)
39
42
DECOMPOSE MEASUREMENTS INTO MULTIPLE HARMONICS
40
CALCULATE MASS UNEVEN DISTRIBUTION COEFFICIENTS AND DETERMINE SIZE AND LOCATION OF ANY MASS UNBALANCE
44
EVALUATE TIRES BASED ON MASS UNBALANCE DETERMINATION
46

Figure 8

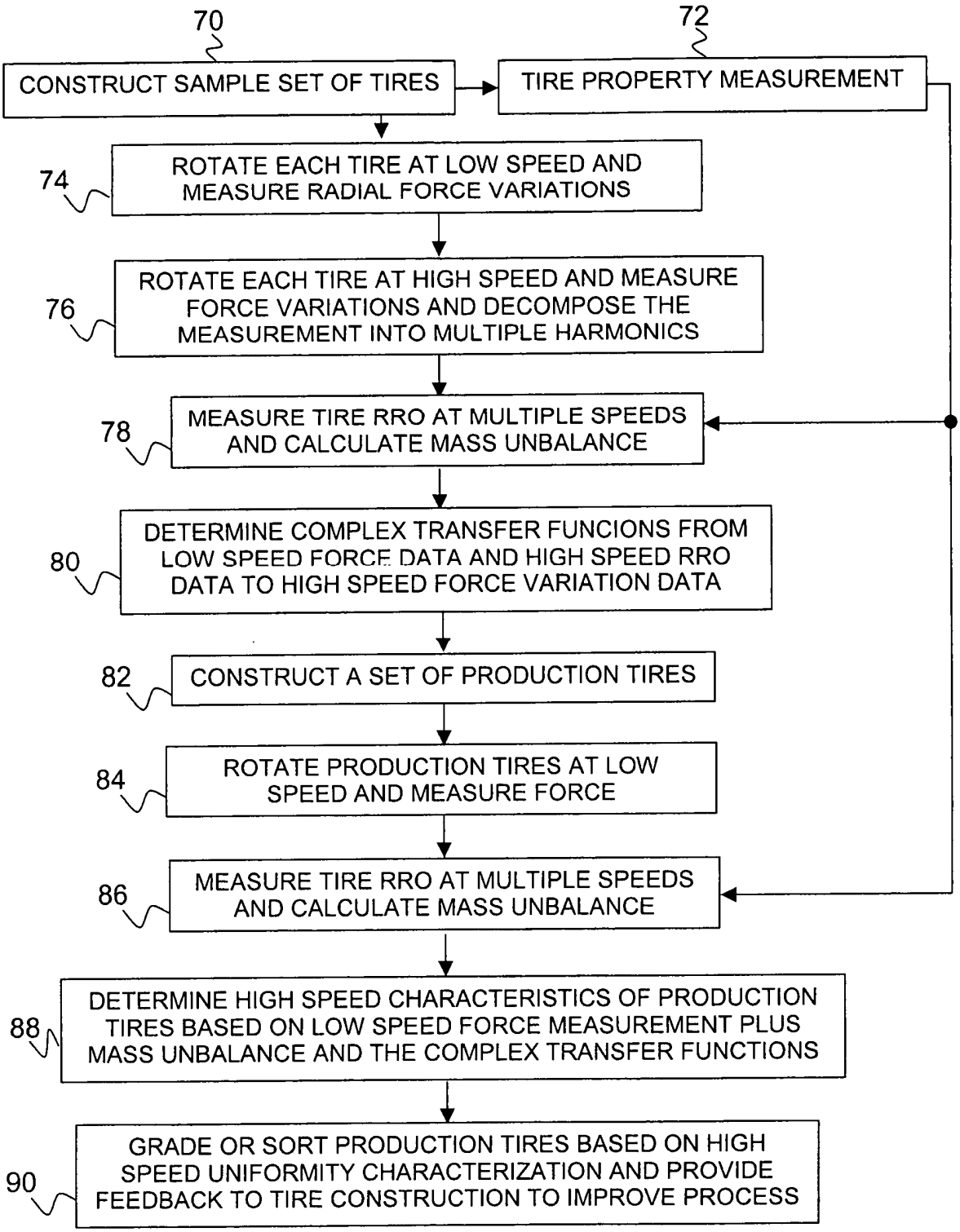
70
CONSTRUCT SAMPLE SET OF TIRES
72
TIRE PROPERTY MEASUREMENT
74
ROTATE EACH TIRE AT LOW SPEED AND MEASURE RADIAL FORCE VARIATIONS
76
ROTATE EACH TIRE AT HIGH SPEED AND MEASURE FORCE VARIATIONS AND DECOMPOSE THE MEASUREMENT INTO MULTIPLE HARMONICS
78
MEASURE TIRE RRO AT MULTIPLE SPEEDS AND CALCULATE MASS UNBALANCE
80
DETERMINE COMPLEX TRANSFER FUNCIONS FROM LOW SPEED FORCE DATA AND HIGH SPEED RRO DATA TO HIGH SPEED FORCE VARIATION DATA
82
CONSTRUCT A SET OF PRODUCTION TIRES
84
ROTATE PRODUCTION TIRES AT LOW SPEED AND MEASURE FORCE
86
MEASURE TIRE RRO AT MULTIPLE SPEEDS AND CALCULATE MASS UNBALANCE
88
DETERMINE HIGH SPEED CHARACTERISTICS OF PRODUCTION TIRES BASED ON LOW SPEED FORCE MEASUREMENT PLUS MASS UNBALANCE AND THE COMPLEX TRANSFER FUNCTIONS
90
GRADE OR SORT PRODUCTION TIRES BASED ON HIGH SPEED UNIFORMITY CHARACTERIZATION AND PROVIDE FEEDBACK TO TIRE CONSTRUCTION TO IMPROVE PROCESS

Figure 9

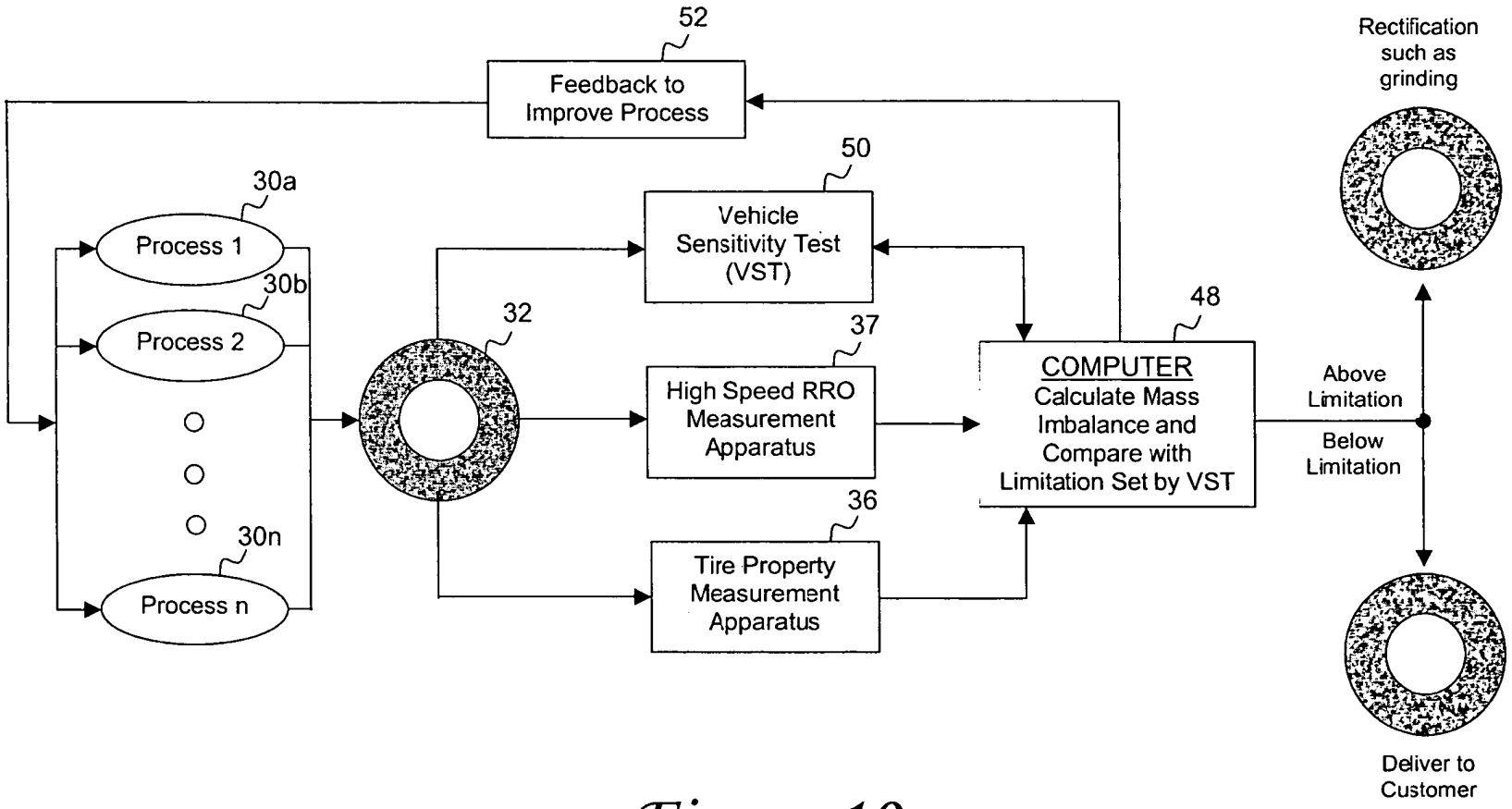
52
Feedback to Improve Process
Rectification such as grinding
50
Vehicle Sensitivity Test (VST)
30a
Process 1
30b
Process 2
32
37
High Speed RRO Measurement Apparatus
48
COMPUTER
Calculate Mass Imbalance and Compare with Limitation Set by VST
Above Limitation
Below Limitation
36
Tire Property Measurement Apparatus
30n
Process n
Deliver to Customer

Figure 10

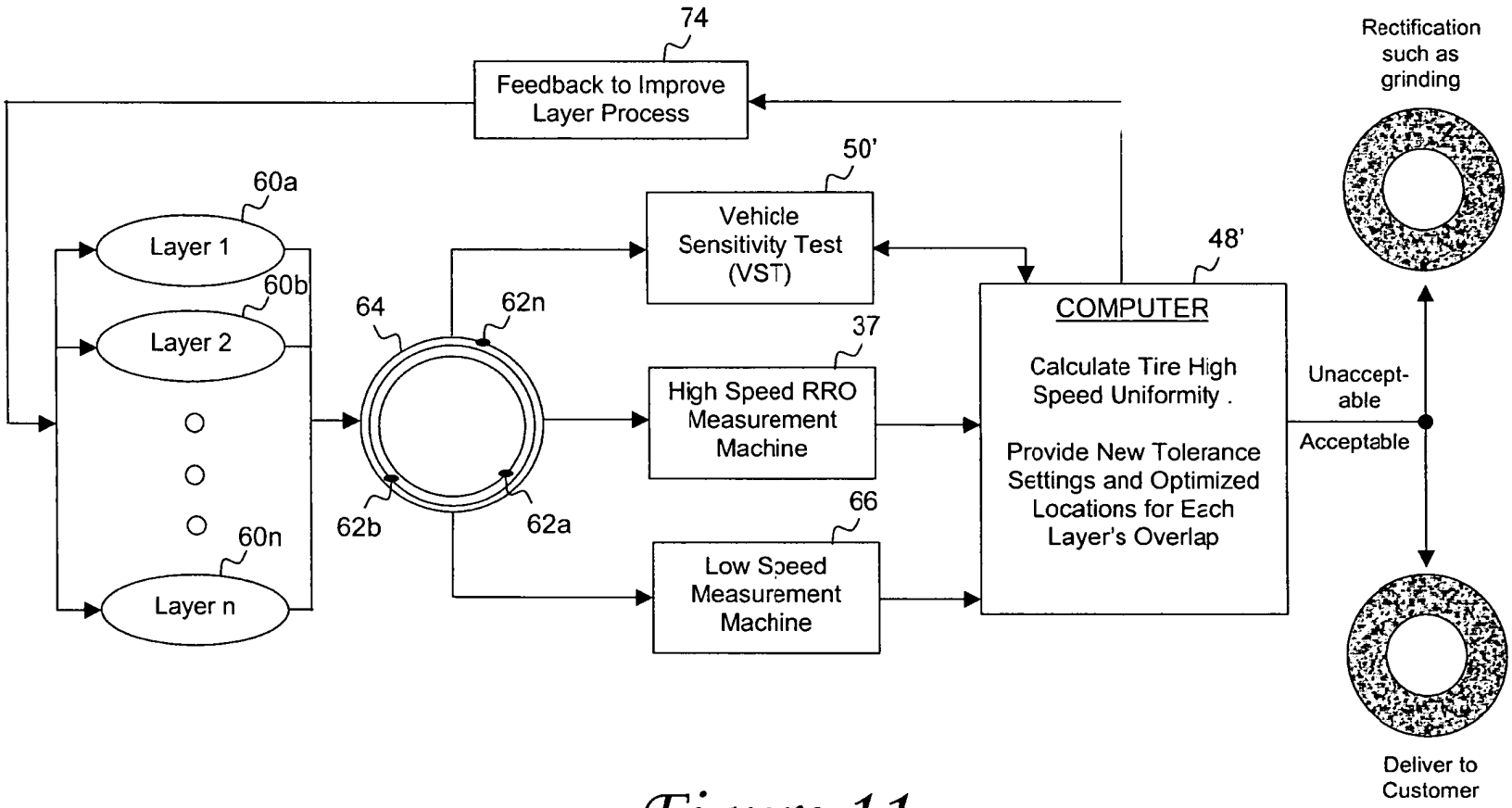
74
Feedback to Improve Layer Process
Rectification such as grinding
50'
Vehicle Sensitivity Test (VST)
60a
Layer 1
60b
Layer 2
64
62n
37
High Speed RRO Measurement Machine
48'
COMPUTER
Calculate Tire High Speed Uniformity .
Provide New Tolerance Settings and Optimized Locations for Each Layer's Overlap
Unaccept-able
Acceptable
66
Low Speed Measurement Machine
60n
Layer n
62b
62a
Deliver to Customer

Figure 11